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Linguistic and psychomotor development in children with chromosome 14 deletions

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Abstract
The present study focussed on a specific type of rare genetic condition: chromosome 14 deletions. Children with this genetic condition often show developmental delays and brain and neurological problems, although the type and severity of symptoms varies depending on the size and location of the deleted genetic material. The specific aim of the present study was to describe the developmental trajectories of language skills in a group of children with linear 14q deletions. Four children with an interstitial deletion of the long arm of chromosome 14 were followed for 1 year. Data collected from psychomotor and linguistic assessments highlight a large individual variability. Considering the children's genetic and clinical conditions, findings revealed that the size of the deleted area is not related to outcome. However, the developmental trajectories of language development are deeply influenced by the presence of clinical conditions, such as autism spectrum disorders.

Keywords: *chromosome 14 deletions*, *language development*, *psychomotor development*, *longitudinal study*, *autistic traits*

Introduction

Insufficient knowledge exists about language development in children with rare genetic diseases, which are, as defined by the European Commission on Public Health, life-threatening or chronically debilitating disorders with a prevalence of fewer than 1 in 2000 people. One reason for the limited information is that rare disorders, as their name implies, involve a restricted number of people. Furthermore, there is substantial individual variability in cognitive and linguistic skills within the same genetic syndrome. Therefore, most studies in the literature contain case descriptions rather than complete overviews of language development in a specific population (e.g. Åkefeldt, Åkefeldt, & Gillberg, 1997, on children with Prader–Willi syndrome; Kristoffersen, 2012, on a child with cri du chat syndrome). Moreover, in these studies, the linguistic skills of the examined cases are considered only at a given point in time, in the absence of any descriptions of the children's developmental trajectories.

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However, the longitudinal study of children with atypical development is particularly important not only to describe a child's present situation, but also to analyse his/her evolving skills, in order to plan appropriate and more effective habilitative treatments. Descriptions of the progression of children's linguistic and cognitive development have been reported for populations involving a wider number of people, such as children with Down syndrome (e.g. Zampini & D'Odorico, 2011a), but rarely on children with very rare genetic syndromes (e.g. Atkin & Lorch, 2007, on a child with Prader–Willi syndrome; Kristoffersen, 2008, on a child with cri du chat syndrome).

The present study is focussed on the linguistic and psychomotor development of children with chromosome 14 deletions, a specific type of rare genetic condition. Various aberrations involving chromosome 14 have been reported, such as the ring 14 syndrome (r14), the linear 14q deletions or duplications, chromosome 14 trisomy and uniparental disomy. Some studies (D'Odorico, Giovannini, Majorano, Martinelli, & Zampini, 2011; Van Karnebeek et al., 2002; Zollino et al., 2009) have compared children with different types of chromosome 14 aberrations and found that children with linear deletions usually show less developmental delay than children with ring 14 syndrome.

Deletion of part of the genetic material on chromosome 14 (usually at the end of the long arm) causes various anomalies. Children with this genetic condition usually show developmental delays in addition to brain and neurological problems, although the type and severity of symptoms can depend on the size or location of the deleted genetic material. As reported in Zollino et al. (2009), children with linear 14q deletions within the terminal 14q24q32.3 region usually show facial dysmorphisms and scoliosis, and they are characterised by a variable degree of intellectual disability.

Other problems that typically occur in children with chromosome 14 aberrations are the presence of behaviour disorders, such as hyperactivity, and the presence of autistic traits, such as motoric stereotypies and echolalia. In particular, a large number of observations supported a strong genotype–phenotype correlation for behaviour problems and autistic traits with region 14q32.1q32.3 (Zollino, Ponzi, Gobbi, & Neri, 2012). Moreover, as shown by D'Odorico et al. (2011), the presence of autistic traits in children with ring 14 syndrome can negatively affect their language development; in fact, out of the four children with ring 14 considered in that study, only the one who did not present autistic traits showed good language development.

The specific aim of the present study is to follow the language development of a group of children with linear 14q deletions during a 1-year period. These observations are also aimed at examining to what extent individual differences in children's psychomotor or linguistic skills could be explained by the size or position of the deleted genetic material, as well as the presence of cerebral anomalies and autistic traits. Due to the wide individual variability, a case description is preferred.

Methods

Participants

Participants were recruited through the "International Association Ring 14" (Reggio Emilia, Italy), founded to promote research on the symptomatology of ring 14 syndrome and all the aberrations associated with chromosome 14.

Four children with chromosome 14 deletions, three females (BF, DMR and DMT) and one male (LL), were followed for 1 year. Two children, BF and LL, were approximately 8 years of age at the beginning of the study, while DMR and DMT were 6-year-old twins.

Genetic analysis was performed by array-CGH on DNA from peripheral blood lymphocytes using the Agilent oligonucleotide array with an average resolution of approximately 75 kb, following the manufacturer's instructions (Human Genome CGH Microarray Kit 44B; Agilent Technologies,

Santa Clara, CA, USA). Balanced 14q rearrangements were ruled out in all parents by locus-specific FISH (30 cells).

A de novo 14q interstitial deletion (i.e. a deletion that does not involve the terminal parts of chromosome 14) was ascertained in each patient. The size of the deletions was measured in mega base pairs (Mb): a deletion of 1 Mb means that 1 million of base pairs (i.e. the building blocks of DNA) are lost. Deletions sized 18 Mb on 14q31.2q32.2 in patients DMR and DMT (arr 14q31.2q32.2 (80 811 994–99 254 905)x1), 10 Mb on 14q31.12q32.2 in patient LL (arr 14q31.12q32.2 (90 527 464–101 647 522)x1) and 2.1 Mb on 14q32.2 in patient BF (arr 14q32.2 (97 909 000–100 020 000)x1).

A detailed medical description is given below for each case.

LL

LL was 07;08 (years;months) at the beginning of the study. He shows typical facies with characteristic hypertelorism and low-set ears, and he was given a diagnosis of a chromosome 14 deletion at 5 months of age during a hospitalisation for recurrent epileptic episodes.

LL suffered from epilepsy since he was 5 months old. He showed postprandial seizures, characterised by eyes rolling back and partial loss of consciousness. The seizures were well controlled with the introduction of valproic acid and did not appear after drug discontinuation when LL was 4.5 years old. EEG at that age revealed an electrical activity slower than would be expected for the patient's age and rare irritative bilateral abnormalities.

While a brain MRI at age 12 months showed a thin corpus callosum, the same examination 3 years later showed no morphological alteration.

LL additionally underwent surgery twice for the correction of equinus valgus-pronated feet.

BF

BF was the same age as LL (07;08), also showing typical facies with hypertelorism and epicanthus. She was diagnosed with a chromosome 14 deletion after an investigation following the observation of general psychomotor delay when she was 11 months old.

BF does not suffer from epilepsy and has no EEG abnormalities. Data from a brain MRI at 2 years of age revealed a hypoplasia of the corpus callosum and an abnormal opercularisation of the right hemisphere.

DMR and DMT

DMR and DMT are monozygous twin sisters and were 05;11 at the beginning of the study. They have downward slanting eyes, and each has a saddle nose.

Brain MRIs at 1 year showed a thin corpus callosum for both sisters. Moreover, each has a congenital heart and kidney defect, as well as the Tetralogy of Fallot with pulmonary stenosis.

Due to the presence of observable autistic traits in DMR and DMT, the Autism Diagnostic Observation Schedule (Lord, Rutter, Di Lavore, & Risi, 1999) was administered. Both girls received a score above the autism cut-off, though no stereotyped behaviours were observed in either child.

Procedure

Children were observed at baseline (first session) and then twice more at 6-month intervals (second session and third session). Two trained observers went to each child's home to assess their linguistic and psychomotor development.

Psychomotor development assessment. The children's psychomotor development was assessed using the Griffiths Mental Development Scales-Extended Revised 2 to 8 years (GMDS-ER 2–8) (Luiz et al., 2006). The test was administered to LL and BF during the second session, held when they were 08;02, and to DMR and DMT when they were 07;05. The GMDS-ER 2–8 is a comprehensive test, containing six sub-scales along with normative data for typically developing children from 2 to 8 years of age. The test assesses children's developmental level in six different areas:

- Locomotor, i.e. gross motor skills (e.g. *autonomous walk*, *jumping skills*);
- Personal–social, i.e. proficiency in the activities of daily living and level of independence (e.g. *sphincter control, independent feeding*);
- Language, i.e. communicative skills (e.g. *language comprehension and production*);
- Eye and hand coordination, i.e. fine motor skills involving manual dexterity and visual monitoring abilities (e.g. *building block towers, drawing a house*);
- Performance, i.e. visuospatial skills including precision and speed of working (e.g. *putting blocks into boxes, completing form boards*);
- Practical reasoning, i.e. the ability to solve problems through actions (e.g. *choosing which one of two objects is the heavier or the smaller*).

Administration of the GMDS-ER 2-8 required approximately 1.5 h for each child. While mothers were in the room during the testing phase, they did not participate in this portion of the assessment.

The scores derived from the administration of the GMDS-ER 2–8 were "age equivalents" in months for each developmental area (i.e. children's developmental age in each sub-scale) and a global score of developmental age in months.

Language development assessment. Language skills were assessed at each of the three study time points. First, parents were asked to complete the Italian version of the MacArthur-Bates Communicative Development Inventories (*Il Primo Vocabolario del Bambino* – PVB; Caselli and Casadio, 1995). The PVB includes two forms. The first form, called "Words and Gestures", is the infant form and it is designed for use with 8- to 16-month-old typically developing children. It contains a vocabulary list of 408 words for assessing both children word comprehension and word production. The second form, called "Words and Sentences", is the toddler form and it is designed for use with 16- to 30-month-old children. This form includes a wider checklist of 670 words to assess children vocabulary production. Either form can be used with older children with developmental disabilities. The first form of the PVB was used for the present study, and children's word production and comprehension were considered by noting the number of words that parents marked on the inventory. For one child, LL, data collected via the PVB during the three sessions were not informative because at the first evaluation, his vocabulary size was higher than that evaluable by this instrument. In fact, LL's mother marked all 670 words on the second form of the PVB

Table I. Children's chronological ages (in years;months) and vocabulary size in production and comprehension (assessed by PVB).

	First session			Second session			Third session		
	Age	PVB Prod.	PVB Comp.	Age	PVB Prod.	PVB Comp.	Age	PVB Prod.	PVB Comp.
LL	07;08	> 670	–	08;02	–	–	08;08	–	–
BF	07;08	–[a]	–[a]	08;02	6	147	08;10	9	173
DMR	05;11	0	204	06;05	2	319	07;01	3	331
DMT	05;11	3	218	06;05	4	329	07;01	4	333

[a]Data not available due to an error in the completion of the inventory.

inventory. Data on lexical comprehension and production for each observation session are shown in Table I.

Each child's spontaneous vocal and gestural production was assessed during 20-min mother-and-child free play sessions, held at the children's homes. Mothers were encouraged to play with their children as normal, using three sets of toys provided by the examiner:

- farm set with a variety of plastic animals, a tractor and different action figures;
- four illustrated books for children;
- doll with a set of small pots and pans and a variety of plastic food.

Every 6–7 min, a new set of toys was introduced to the mother–child dyads, but they were still free to play with the one they preferred. Children were discouraged from using toys and objects not included in these sets to maintain equivalence across play sessions.

Each mother–child play session was recorded on video. A trained observer subsequently used the CHAT format system to transcribe the communicative production of each mother and child (MacWhinney, 2000).

Coding and measures

In examining children's vocal productions, the unit of analysis corresponds to an utterance, defined as the production of a unitary intonational pattern within a single dialogic turn, separated from other utterances by a pause of more than 1 s (D'Odorico & Jacob, 2006). All children's utterances were classified as either preverbal (i.e. vocal productions at a lower level than word productions) or verbal (i.e. words and multi-word utterances).

Preverbal utterances were classified based on the following coding scheme:

- vocalisations, i.e. vowel productions and grunt productions (e.g. *oh*, *mh*);
- babbling, i.e. consonant–vowel productions (e.g. *bababa*, *de*);
- onomatopoeias, i.e. productions that imitate a sound (e.g. "*bau bau*" (*woof woof*), "*toc toc*" (*knock knock*)).

Verbal utterances were classified as follows:

- Single words, i.e. utterances constituted by a single significant element (e.g. "*cucchiaio*" (*spoon*), "*vai*" (*go*));
- Transitional forms, i.e. utterances composed by two or more vocal elements, at least one of which was a word, but not connected by a semantic link. For instance, an utterance constituted by the repetition of the same word (e.g. "*casa casa*" (*home home*)) is coded as a transitional form. For a complete description of these transitional utterances, please refer to Zampini and D'Odorico (2011b);
- Multi-word utterances, i.e. utterances composed of two or more words connected by a semantic link. This category was sub-divided into:

- utterances without a verb (e.g. "*un tavolo grande*" (*a big table*));
- simple utterances, i.e. characterised by the presence of one single verb (e.g. "*Emma è la mia bambola*" (*Emma is my doll*));
- complex utterances, i.e. characterised by the presence of at least two verbs and constituted by a main clause and a subordinate clause (e.g. "*sta correndo perché è tardi*" (*he's running because he's late*)).

To analyse children's lexical skills, the following two measures were obtained from children's spontaneous verbal production:

- word tokens, i.e. the total number of words uttered during each 20-min observation session;
- word types, i.e. the number of different words (inflectional roots) produced during each 20-min observation session.

Regarding nonverbal communication, the communicative gestures produced by the children during the three observation sessions were classified into the following categories (Zampini & D'Odorico, 2011a):

- pointing (i.e. extending the index finger in the direction of an object, a person or an event);
- showing (i.e. holding up an object in the listener's line of sight);
- conventional gestures (i.e. gestures with a culturally defined meaning and form (e.g. waving bye-bye, nodding or shaking the head));
- iconic gestures (i.e. gestures that refer to objects, persons or events, reproducing their physical or functional characteristics (e.g. putting a hand on the head to indicate a *hat* or flapping arms to indicate *flying*)).

Results

Due to the high individual variability generally identified in the development of children with genetic syndromes, and more specifically in children with chromosome 14 aberrations, aspects of the children's psychomotor and linguistic development were analysed separately. A schematic summary of the word types and word tokens produced by the children during the three sessions is reported in Table II.

LL

The psychomotor development of LL was assessed during the second observation session when LL was 08;02. He collaborated very well with the examiner, performing each proposed task. His global developmental age, assessed by the GMDS-ER 2–8, was 43 months. Scores obtained in each developmental area are shown in Figure 1. It is noteworthy that one of the lowest scores was obtained in the locomotor area, likely due to impaired ambulation associated with equinus valgus-pronated feet. Another area of weakness was in the performance sub-scale due to the influence of motor awkwardness on his precision and speed of working. The eye and hand coordination sub-scale, that is another area connected with motor development, was less compromised, because it involves manual dexterity and visual monitoring abilities, but not the speed of working needed to solve the performance sub-scale tasks.

Regarding language development, LL showed the highest developmental level in this sample. His production was almost exclusively verbal (apart from a few onomatopoeias), and he was the only one to produce multi-word utterances (i.e. utterances without verbs, simple utterances and complex utterances). LL produced a constant quantity of utterances during the three 20-min sessions, with

Table II. Children's spontaneous word production during the three observation sessions.

	First session		Second session		Third session	
	Word types	Word tokens	Word types	Word tokens	Word types	Word tokens
LL	62	184	114	429	125	433
BF	2	3	2	10	5	33
DMR	0	0	0	0	0	0
DMT	2	5	1	1	1	1

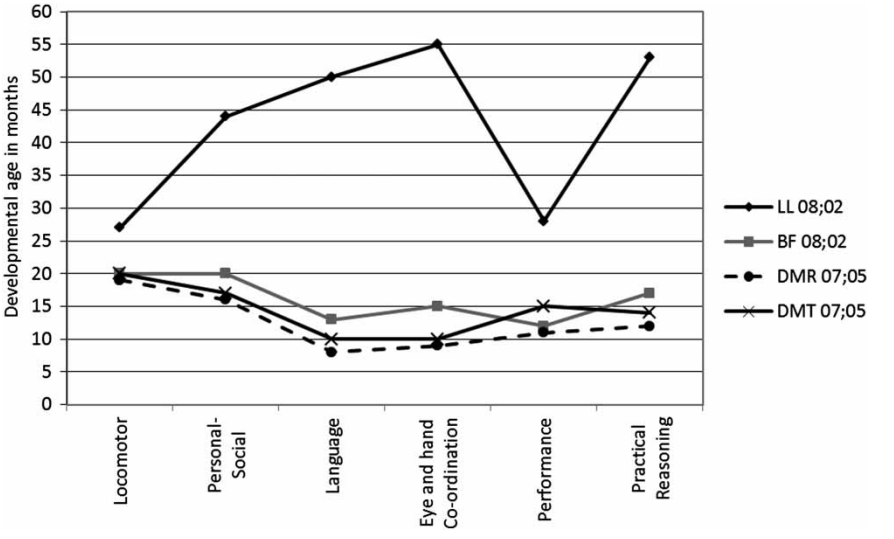

Figure 1. Children's developmental age, assessed by the GMDS-ER 2–8.

approximately 150 verbal utterances per observation session (142 during the first session, 153 during the second and 145 during the third). During the 1-year follow-up period, LL showed a slow increase in the complexity level of his productions. As shown in Figure 2, the proportion of single-word utterances progressively decreased while that of complex utterances increased, though this kind of utterance represented less than 10% of the total production even in the third session. Examining in detail the complex utterances produced by LL, it is possible to observe that they are almost all completive clauses (e.g. "*io so che cosa sono*" (*I know what they are*)) apart from two conditional clauses uttered in the second session ("*io metto tutti gli animali se ci stanno*" (*I'll put all the animals if they fit*); "*io provo a mettere l'oca se ci sta*" (*I'll try to put the goose if it fits*)) and a temporal clause uttered in the third session ("*quando andate dal dentista io gioco da solo*" (*when you go to the dentist I'll play alone*)).

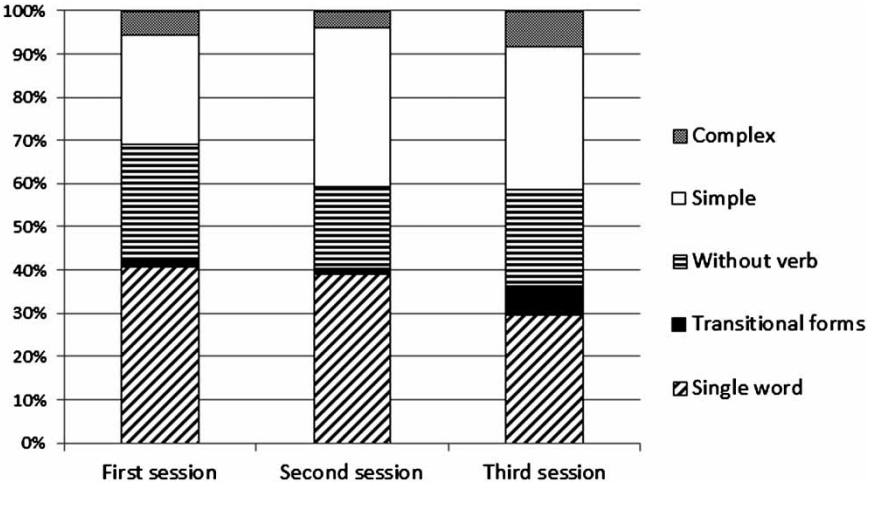

Figure 2. LL's proportion of verbal utterances during the three observation sessions.

Furthermore, examining lexical development across the three observations, LL increased the number of both word types (62; 114; 125) and word tokens (184; 429; 433) from sessions 1 to 3.

Regarding gesture production, LL showed a constant production of communicative gestures: 19 in the first session, 12 in the second one and 18 in the last one. However, these gestures are almost always used in association with word production, and not in place of it.

BF

BF's psychomotor development was also assessed during the second observation session at 08;02. BF achieved a global developmental level of 16 months. Scores obtained in all of the Griffiths subscales, shown in Figure 1, ranged from 12 to 20 months. The highest scores were reached in the locomotor and personal–social areas, whereas the lowest scores were obtained in the performance and language areas.

As apparent from the administration of the psychomotor scale, BF's language development was lower than that expected for her developmental age. However, direct observation of her spontaneous production revealed both an increase in the total number of communicative utterances produced during the 20-min observations (39 and 36 in the first two sessions and 56 in the third one) and a gradual increase in the proportion of verbal utterances, as shown in Figure 3. BF's preverbal utterances were mainly composed of vocalisation and onomatopoeias, with a limited production of babbling (3, 12 and 0% in the first, second and third sessions, respectively). This observation highlighted a general problem in producing the consonant–vowel associations that form the basis of word production. Additionally, the limited production of verbal utterances reflected BF's difficulty in articulating words, as only two different word types were produced in the first (i.e. "*pappa*" (*baby food*) and "*mamma*" (*mum*)) and second observation sessions (i.e. "*no*" (*no*) and "*mamma*" (*mum*)), and only five word types were produced in the last session (i.e. "*no*" (*no*), "*si*" (*yes*), "*là*" (*there*), "*acqua*" (*water*), pronounced [aha] and "*pane*" (*bread*), pronounced [pahe]). In fact, the increased percentage of verbal utterances was mainly due to the increase in the number of word tokens (3; 10; 33) because in the second and third assessment, BF tended to repeat the same words many times. It is noteworthy that the verbal utterances were almost always

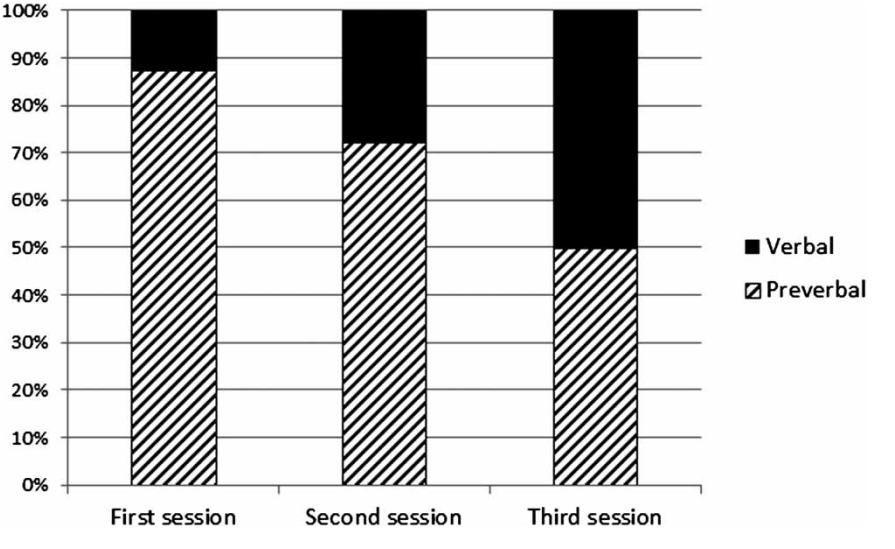

Figure 3. BF's proportion of preverbal and verbal utterances during the three observation sessions.

composed of a single word, with the exception of a few transitional forms in which she twice repeated the same word (e.g. "*no no*" (*no no*)).

Regarding communicative gestures, BF used communicative gestures frequently, with 31, 30 and 42 gestures in the first, second and third sessions, respectively. She consistently produced deictic gestures (i.e. pointing and showing), reaching 31–37% of her total production. Whereas the proportion of iconic gestures decreased over time (13% during the first session and 0% in the following sessions), the proportion of conventional gestures gradually increased (52, 63 and 69%). This trend underlines the progressive development of BF's communicative system. She reduced the use of iconic gestures, which have the function of substituting for words, while incrementally increasing the production of conventional gestures, which usually accompany spoken language even in the adult communicative system.

DMR

DMR's psychomotor development was assessed 4 months after the third language observation session, at 07;05. Data from the Griffiths scales showed a very low developmental level, with a mean developmental age of 13 months. The highest score was in the locomotor area (19 months), whereas the primary delays were in the linguistic (8 months) and eye and hand coordination (9 months) areas, as reported in Figure 1.

Regarding language development, DMR's vocal production was entirely preverbal during the three observation sessions. An increase in the number of utterances produced was observed between sessions 1 and 2 (42, 70 and 75 utterances produced in the first, second and third observations, respectively). However, as shown in Figure 4, the composition of the preverbal utterances did not show an increase in complexity as the percentage of babbling did not show a linear trend. It is noteworthy that DMR's sound repertoire was similar to that of typically developing children at their first stages of vocal development: it was mainly constituted by vowel sounds (i.e. [a], [e]) and labial consonants (i.e. [b], [p], [m]).

Moreover, it must be noted that aside from two pointing gestures and one conventional gesture (shaking head to communicate refusal) produced during the first observation session, production of communicative gestures was almost completely absent.

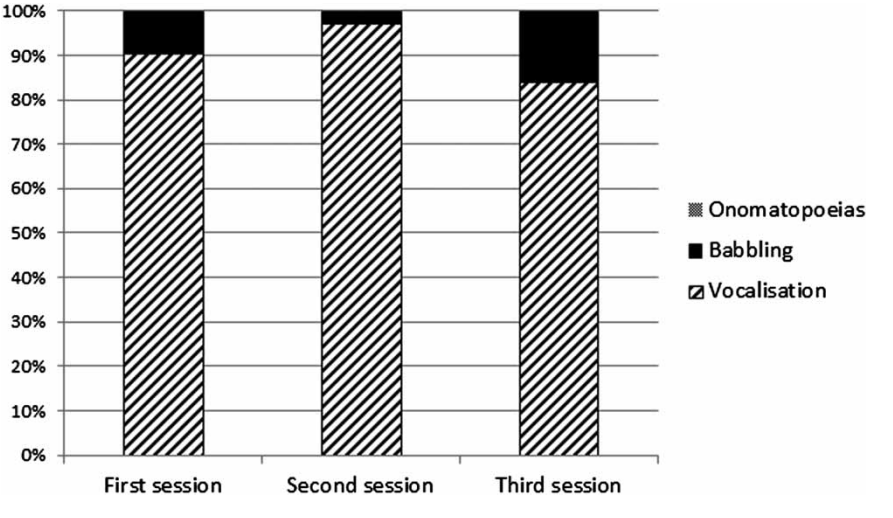

Figure 4. DMR's composition of preverbal utterances during the three observation sessions.

DMT

DMT's psychomotor development was assessed on the same day as DMR, at 07;05. Data from the Griffiths scales showed a developmental age of 14 months for DMT. While the distribution of scores among the different sub-scales was similar for both twins, DMT obtained one or two additional points (i.e. months in developmental age) in each sub-scale except performance, where she gained an additional four points relative to her twin sister, as shown in Figure 1.

Concerning language development, DMT's vocal production was almost completely preverbal, except for the production of two words ("*mamma*" (*mum*) and "*papà*" (*dad*)) during the first session, one during the second ("*pappa*" (*baby food*)) and one during the third one ("*mamma*" (*mum*)).

The number of utterances produced was quite constant across the observation sessions (70, 67 and 80 utterances). Moreover, as shown in Figure 5, the composition of preverbal utterances did not show an incremental pattern in the level of complexity. As with DMR, an increasing trend of consonant productions was not identifiable. Moreover, also DMT's sound repertoire was very simple: only vowel sounds and labial consonants were produced, as can be seen from the words uttered.

Moreover, as identified in her twin sister, the production of communicative gestures was almost completely absent, apart from one pointing gesture produced during the first session and one conventional gesture (waving bye-bye) produced during the third observation session.

Case comparison. Data collected from both the psychomotor and the linguistic assessment highlight the existence of a wide individual variability in the group of children with linear 14q deletions. The most evident distinction was between the developmental skills reached by LL and those achieved by the other three participants. With a global developmental age of 43 months, LL displayed the highest developmental level in this group of children. His greatest delays were in the locomotor area, and his linguistic production was almost exclusively verbal. Moreover, he was the only one who produced multi-word utterances. BF, DMR and DMT showed global developmental levels that were significantly lower than their chronological ages. Specifically, BF (chronological age: 8;02) had a mental age of 16 months, whereas DMR and DMT (chronological age: 7;05) had

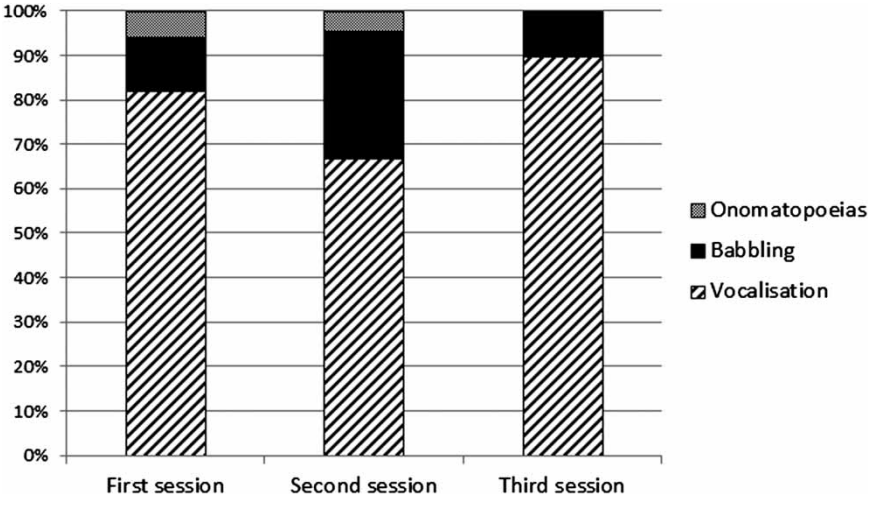

Figure 5. DMT's composition of preverbal utterances during the three observation sessions.

mental ages of 13 and 14 months, respectively. Furthermore, the distribution of scores among the Griffiths sub-scales was similarly characterised by higher developmental levels reached in the locomotor and personal–social areas and a lower level reached in the language area. In fact, the linguistic production of DMR and DMT was almost exclusively preverbal and nearly the 90% of the production of BF was preverbal during the first session. In the area of language development, LL showed a gradual increase in the complexity level of his verbal productions. The same trend was observed in BF, who showed a significant increase in her verbal production from the first to the third session (13–50%). In contrast, neither DMR nor DMT showed any improvement in their language production during the 1-year observation. DMR remained completely preverbal, and DMT produced only a very limited number of verbal productions (two words per session on average). Even when considering their preverbal productions, no increases in the observed level of complexity could be identified. The same developmental pattern was identified in gesture production. Specifically, during the 1-year follow-up, BF showed an increase in the production of communicative gestures, while DMR and DMT displayed no change in their very limited gesture production over time.

General conclusions

The specific aim of the present study was to describe the linguistic and psychomotor development of children with linear 14q deletions and to examine whether individual differences in the achievement of developmental skills could be explained by the participants' genetic or clinical characteristics.

All of the participants in the study showed the delays in psychomotor development and facial characteristics commonly described in the literature for children having a deletion on the terminal portion of chromosome 14q (Van Karnebeek et al., 2002; Zollino et al., 2009). Epilepsy, usually found in children with ring 14 but rarely in children with linear deletions, was found in one child (LL), but in a benign form.

The wide individual differences found in children's psychomotor and linguistic development were considered in relation to their genetic conditions. Considering the size of the deleted genetic material, a possible initial conclusion is that a smaller amount of deleted material is not necessarily related to a better outcome. In fact, BF, who has a deletion of 2.1 Mb, showed a significantly lower developmental level than LL (16 vs. 43 months), who had the same chronological age and a deletion of 12 Mb. This result confirmed that found by Zollino et al. (2009), who discovered, in children with ring 14, that intellectual disability was due to the ring configuration of the chromosome, rather than the extension of the deletion (i.e. the loss of genetic material).

However, considering children's clinical conditions, it is noteworthy that the developmental trajectories of language are deeply influenced and negatively affected by the presence of autism spectrum disorders. DMR and DMT, who had a remarkable presence of autistic traits as assessed by the ADOS, did not show any increasing trend in their communicative abilities, contrary to the other children. The presence of atypical developmental trends in children with autism spectrum disorders has been extensively documented in the literature (e.g. Charman et al., 2005). An illustrative example is the existence of "autistic regressions". During the second year of life, between 15 and 40% of children with autism show a regression, that is, a loss of spoken language and social skills after an apparent period of normal development or, in some cases, a delay in the acquisition of these skills (Baird et al., 2008).

Therefore, as already found in other populations, such as children with Down syndrome (Dressler, Perelli, Bozza, & Bargagna, 2011), even in children with chromosome 14 deletions, the presence of autistic traits in association with cognitive impairment appeared to be a critical factor in predicting outcomes.

In conclusion, although the small number of cases involved in this study does not allow one to make a generalisation of language development to the entire population of children with linear 14q deletions, our data illustrate the existence of a wide individual variability that is highly influenced by children's clinical characteristics and global developmental level.

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Declaration of Interest: The authors report no conflict of interest.

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